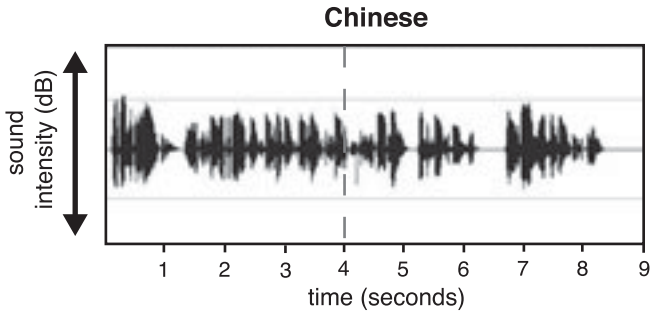
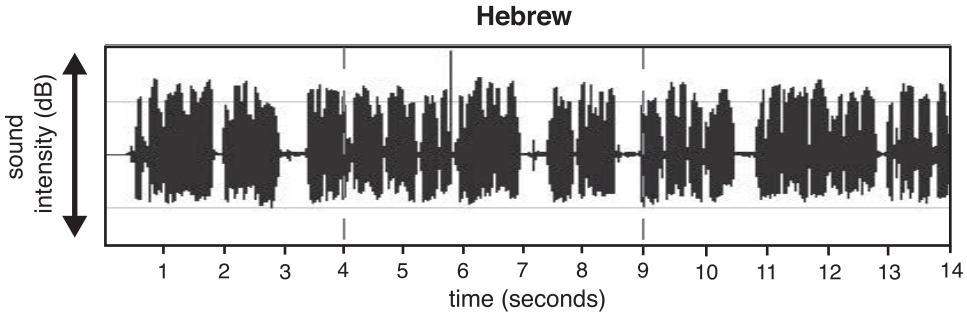
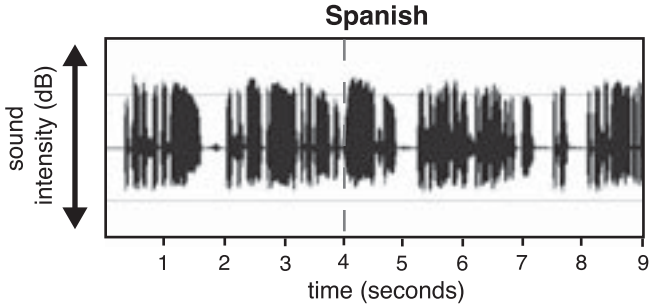
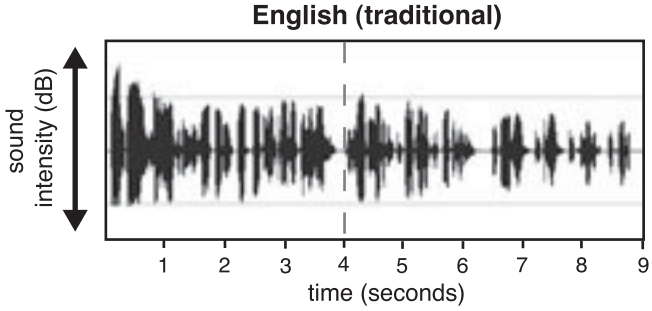
The Rhythm of Language









Master 1.1

Stories of Language Development

BIRDSONG

A male white-crowned sparrow usually begins singing its full song between 100 and 200 days of age. Having the proper song is necessary for mating and marking its territory. However, to learn its song, the young bird must be exposed to an adult bird's song consistently and frequently between one week and two months after hatching. That is its critical period for learning its song. Both before and after this critical period, the male sparrow is unable to use any adult sounds to learn its characteristic song.

WILD CHILD

In 1799 in Aveyron, France, a boy thought to be about 11 or 12 years old was discovered in the woods foraging for food. He became known as the "wild child of Aveyron," because he behaved like an animal. He happily ate spoiled food, did not distinguish between hot and cold, thought nothing of romping unclothed through the snow, spent much of his time rocking back and forth like a caged animal, showed and accepted no affection, and possessed no verbal language. He was taken into the care of a French scientist, who spent a number of years trying to educate the boy. Victor, as he was named, eventually learned some basic skills and developed some language comprehension. However, he learned to say only two expressions: "milk" and "Oh, God."

Sound Safari Data Sheet

Name_____ Date_____

VOICED	MUSICAL	ENVIRONMENTAL

Master 2.1

The Decibel Scale

Name_____ **Date**_____

Imagine hearing the softest sound that you can possibly hear. Then imagine that this sound is made louder and louder until it is so loud, it is physically painful to hear it. How much louder do you think the loudest sound would be compared with the softest?

You may be surprised to learn that a painfully loud sound would be more than 16,384 times as intense as the softest sound. In other words, your ears can hear a range of sounds that increase from a sound intensity of 1 unit to an intensity of 100 trillion units. To think of it another way, you began life as a single cell. But by the time you reach adulthood, you'll be made of 100 trillion cells.

Because such an enormous range of numbers (from 1 to 100 trillion) can be difficult to work with, scientists have devised a special scale to use when measuring the intensity of sounds. This scale is called the decibel scale.

Study the patterns made by the numbers in the first two columns of the table on the next page. Then fill in the missing numbers in the columns labeled "Sound Intensity" and "Decibels (dB)."

Answer the questions below to learn more about the decibel scale.

1. How many times more intense is a sound of 30 dB than a sound of 20 dB? A sound of 40 dB than a sound of 20 dB?

2. How many times more intense is the sound of an alarm clock than a quiet room?

Sound-Intensity Table

Name_____ Date_____

Sound Intensity	Decibels (dB)	Sounds
1	0	just detectable
10	10	
100	20	
1,000	30	
10,000	40	quiet room
		normal conversation
		alarm clock
		rock concert (90–130 dB)
		shout into ear at 20 cm
100,000,000,000,000	140	air raid siren

Loudness and Pitch

Name_____ Date_____

Enter the results of your investigation of the relative loudness of sounds at different pitches (frequencies) as measured in hertz (Hz).

Frequency (Hz)	62.5	125	250	500	1,000	2,000	4,000	8,000	11,000
Relative loudness									

Discussion Questions

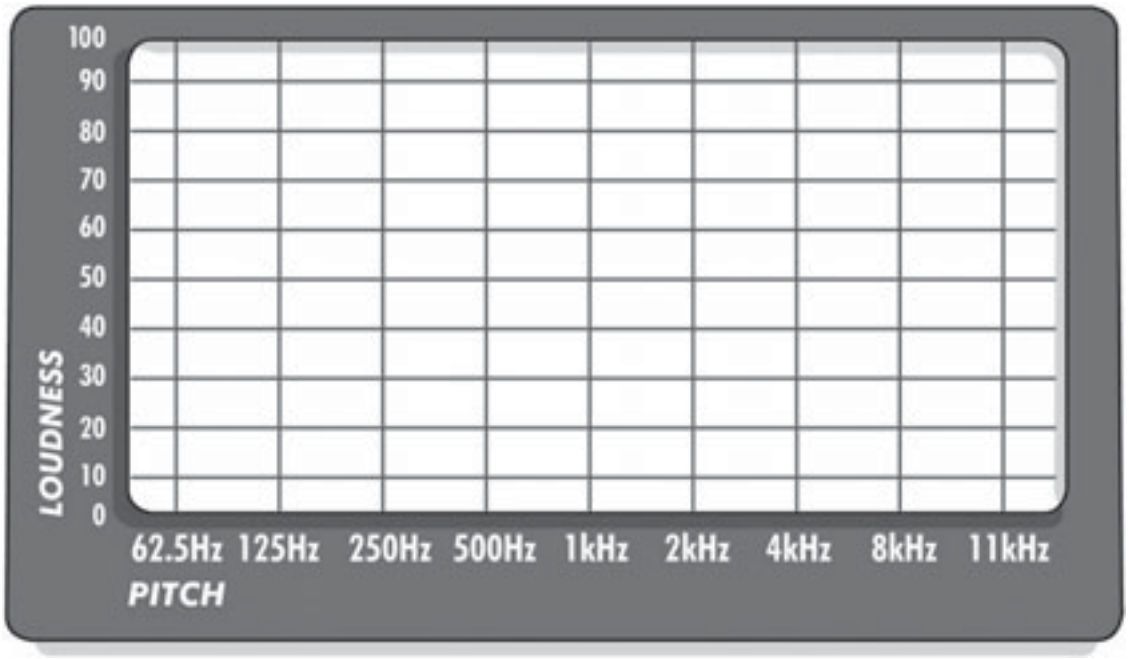
1. Did the sounds produced at each frequency seem equally loud? How did the loudness change with frequency?

2. Why did you hear variation in loudness with changing pitch?

Hearing Response

Name_____ Date_____

Frequency (Hz)	62.5	125	250	500	1,000	2,000	4,000	8,000	11,000
Loudness Value on y-axis									

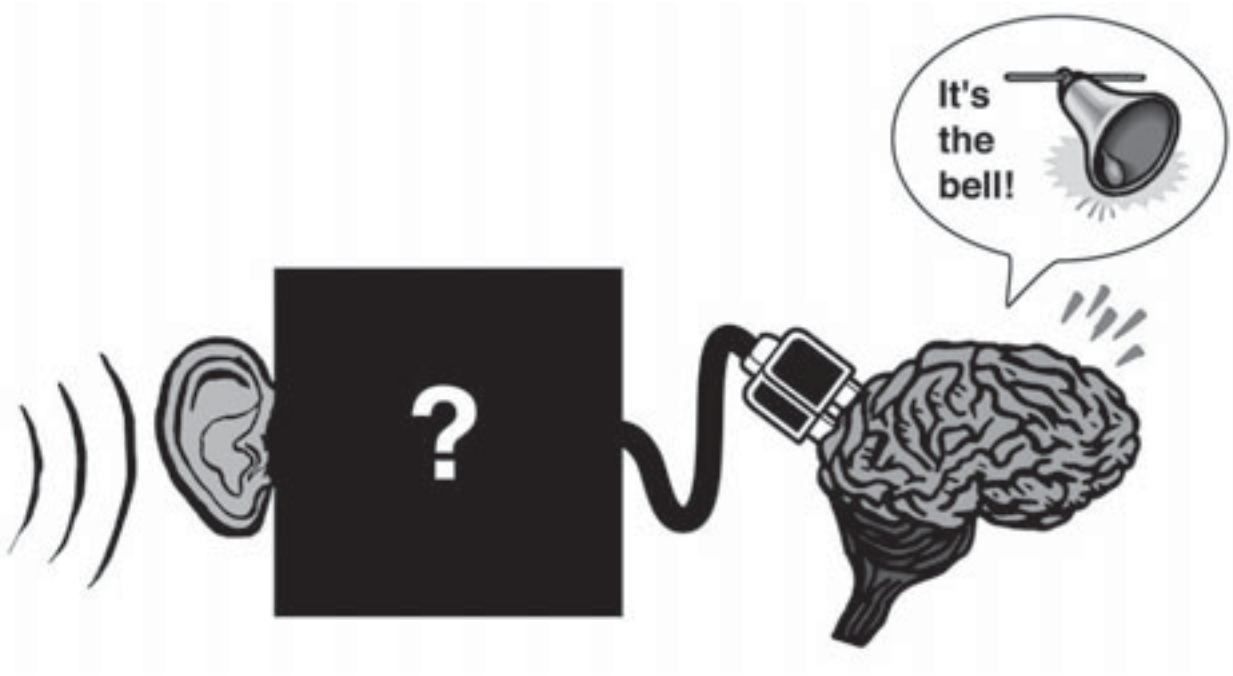


Discussion Questions

1. At what frequencies is your hearing most sensitive? Circle these frequencies on your graph.

2. As we get older or are repeatedly exposed to loud sounds, we tend to lose hearing at higher frequencies. How might the hearing-response curve change for an individual with high-pitched hearing loss?

The Mysterious Black Box



A Few Questions

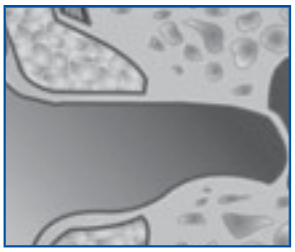
1. What do the lines between the bell and the ear indicate?

2. What is a sound wave?

3. Do vibrations reach all the way into the brain to let us hear sound?

Black Box Cards

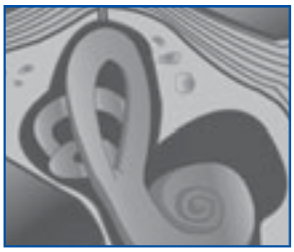
Focuses sound waves; helps in determining the direction from which sound waves arrive.



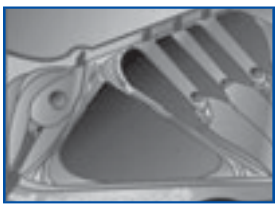
Conducts sound waves to the eardrum.

Vibrates in response to arriving sound waves.

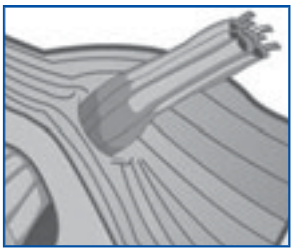
System of bones that works as a lever system to transmit vibrations deeper into the ear and to increase the vibrations' force.



Liquid inside this structure transmits pressure waves in response to vibrations.



Tiny hairlike extensions on the cells in this structure move in response to pressure waves in surrounding liquid, causing cells to make generate electrical impulses that vary according to the waves' amplitude and frequency.



Carries electrical impulses to the brain.

Interprets electrical impulses as sounds of varying pitch, loudness, and timing.

The Bell Card

Understanding Form and Function

Name(s)_____ **Date**_____

Part 1
Now that you have properly identified the ear's transducer, write "yes" beside each phrase that correctly describes one of its characteristics. Write "no" beside each phrase that does not.

_____ responds to pressure waves in a liquid

_____ vibrates in response to sound waves

_____ converts vibrational energy to electrical energy

_____ increases the force of vibrations inside the ear

_____ generates nervous impulses

_____ is located in the cochlea

Part 2
Use your understanding of the hearing pathway to predict the effect each of the following would have on hearing. Use the choices below for your answers.

For each of the following situations, hearing would

- be unaffected
- gain loudness
- lose loudness
- lose information about pitch
- be lost completely

_____ fingers blocking the ear canal

_____ ruptured eardrum

_____ cut the auditory nerve

_____ link between the incus and stapes broken

_____ buildup of ear wax

_____ hand cupped behind the pinna

_____ damage to hair cells in the cochlea

_____ damage to part of the brain that processes electrical impulses arriving from the cochlea

Understanding Form and Function

Part 3
People with hearing loss can sometimes be helped by technology. The two most common devices used by people with hearing loss are hearing aids and cochlear implants.

A hearing aid uses a small microphone to collect sound, which is then amplified as an electrical signal that is reconverted to sound using a small loudspeaker.

A cochlear implant uses a small microphone to collect sound, which is then electronically processed into a form that the brain can interpret. The information is then transmitted through a collection of electrodes.

Identify which statements refer to a hearing aid, which refer to a cochlear implant, or both.

a. It works as a transducer, converting vibrational energy to electrical (electrochemical and electromechanical) energy. _____

b. It helps people whose hearing loss is caused by problems in the outer or middle ear. _____

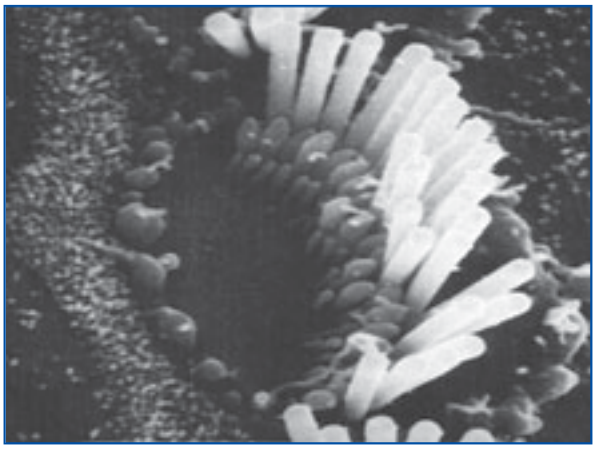
c. It increases the vibrational energy entering the ear. _____

d. It helps sounds bypass injured or absent hair cells. _____

e. It helps people whose hearing loss is caused by problems in the inner ear. _____

f. It can help profoundly deaf people communicate using sound. _____

Electron Micrographs of Hair Cells



Healthy hair cells (left) and damaged hair cells (right). Diameter of hair cells is approximately 10 µm (micrometers). (One micrometer is one-millionth of a meter.) Diameter of one stereocilium is approximately 250 nm (nanometers). (One nanometer is one-billionth of a meter.) For a video clip of the magnified version of healthy hair cells, go to this Web site: *http://science.education.nih.gov/supplements/hearing/student* and click on the button labeled "Lesson 5—Too Loud, Too Close, Too Long."

Loud, Louder, and Loudest

Name_____ Date_____

Approximately how loud are the sounds listed below? Write each sound where you think it belongs on the page. Two sounds are provided as examples.

jet plane during takeoff, lawn mower, waterfall (at the base), large 18-wheel truck, quiet neighborhood, train, third row at an amplified rock concert, car horn, your living room at home, low whisper, electric vacuum cleaner, fire siren, traffic at a busy intersection

Sound Intensity (dB)	Type of Sound
140 (very painful)	
130	
120 (painful)	
110	chain saw
100	
90 (extremely loud)	
80	
70 (very loud)	
60	
50 (moderate)	
40	
30	low whisper
20	
10	
0 (softest sound humans can hear)	

Answer Key to Loud, Louder, and Loudest

Sound Intensity (dB)	Type of Sound
140 (very painful*)	jet plane during takeoff, fire siren
130	third row at an amplified rock concert
120 (painful)	
110	chain saw
100	
90 (extremely loud)	traffic at a busy intersection, waterfall (at its base) train, lawn mower
80	18-wheel truck
70 (very loud)	electric vacuum cleaner
60	living room at home
50 (moderate)	car horn
40	quiet neighborhood
30	low whisper
20	
10	
0 (softest sound humans can hear)	

*140 decibels (dB) is 100,000,000,000,000 (or 100 trillion) times more intense than 0 dB.

Dangerous Sound Levels

dB	Type of Sound
140	Threshold of pain
130	Threshold of pain
120	Threshold of pain
110	Regular exposure of more than 1 minute risks permanent hearing loss.
100	No more than 15 minutes of exposure is recommended.
90	Prolonged exposure to any noise above 90 dB can cause gradual hearing loss. Level at which hearing damage after 8 hours exposure begins: 85 dB.
80	Constant exposure may cause damage.
70	
60	Comfortable: under 60 dB
50	
40	
30	
20	
10	
0	

Some Everyday Sounds

Sound	dB level
hearing threshold	0
breathing	10
rustling leaves	20
whispering	25
library	30
refrigerator	45
average home	50
normal conversation	60
clothes dryer	60
washing machine	65
car	70
vacuum cleaner	70
busy traffic	75
noisy restaurant	80
outboard motor	80
inside car in city traffic	85
electric shaver	85
screaming child	90
passing motorcycle	90
convertible ride on highway	95

Sound	dB level
table saw	95
hand drill	100
tractor	100
diesel truck	100
circular saw	100
jackhammer	100
gas-powered mower	105
helicopter	105
chain saw	110
amplified rock concert	90–130
shout into ear	120
car horn	120
siren	120
threshold of pain	120–140
gunshot	140
jet engine	140
12-gauge shotgun	165
rocket launching	180

Sound Diary Summary—Joe, the Guitarist

Name(s)_____ Date_____

Joe is 20 years old, and he has been the lead guitarist in a rock band for four years. The group is doing well; they rehearse a lot and play at local clubs on weekends. Joe commutes on busy freeways quite a bit. He is single and likes his quiet life at home but still enjoys the fast pace of the big city when he's there.

Use *Some Everyday Sounds* and the table below to analyze Joe's exposure to sound. Enter an estimated dB level for each sound listed in the first column. Where appropriate, indicate how the risk of hearing loss might be lowered. In the right column, enter any information that explains your dB estimates. For example, your choice of a dB level for eating lunch assumes either a quiet or a noisy environment.

Source of sound (major activities)	Time per week (minutes)	Estimated dB level	Suggestions for lowering risk of hearing loss	Comments
morning activities	210			
breakfast at home	140			
freeway commute to/from work	300			
morning rehearsal	900			
lunch at restaurant	420			
lunch at home	120			
afternoon rehearsal	1020			
dinner at restaurant	600			
dinner at home	120			
gigs at local night spots	480			
listening to music	1300			
watching TV	480			
reading	120			

Sound Diary Summary—Maria, the Woodworker

Name(s)_____ Date_____

Maria is 19 years old and single. Her father, a master craftsman, introduced her to tools and woodworking when she was in elementary school. She now works for a small business, designing and constructing cabinets and other fine wood products for the home. She lives in a small town and has a very short drive to work.

Use *Some Everyday Sounds* and the table below to analyze Maria's exposure to sound. Enter an estimated dB level for each sound listed in the first column. Where appropriate, indicate how the risk of hearing loss might be lowered. In the right column, enter any information that explains your dB estimates. For example, your choice of a dB level for eating lunch assumes either a quiet or a noisy environment.

Source of sound (major activities)	Time per week (minutes)	Estimated dB level	Suggestions for lowering risk of hearing loss	Comments
morning activities	315			
breakfast at home	150			
commute to/from work	50			
working in office designing projects	900			
using power tools to make cabinets	1500			
lunch in office	300			
lunch at home	120			
dinner at home	420			
college night classes	600			
listening to rock music on Walkman	900			
watching TV	600			
reading	850			

Sound Diary Summary—Michael, the Landscaper

Name(s)_____ Date_____

Michael is 26 years old, a graduate of a local college, and the owner of his own landscaping and lawn-care service. He is married and the father of two-year-old twins. He drives a large pickup truck, which pulls a trailer containing his mowers, chain saw, shovels, and other equipment for work. Business is good, and he has many clients around town.

Use *Some Everyday Sounds* and the table below to analyze Michael's exposure to sound. Enter an estimated dB level for each sound listed in the first column. Where appropriate, indicate how the risk of hearing loss might be lowered. In the right column, enter any information that explains your dB estimates. For example, your choice of a dB level for eating lunch assumes either a quiet or a noisy environment.

Source of sound (major activities)	Time per week (minutes)	Estimated dB level	Suggestions for lowering risk of hearing loss	Comments
morning activities, caring for twins	320			
breakfast at home	120			
commute to/from jobs	700			
mowing lawns	1500			
tree trimming	300			
dinner at home	420			
watching TV	1320			
helping with twins at night	800			

Sound Diary Summary—George, the Firefighter

Name(s)_____ Date_____

George is 23 years old and married. After graduating from college, he joined the local fire department. When he is not on duty, he works on his farm. He is also remodeling the basement of their home. George's wife is a violinist. Music is important to both of them.

Use *Some Everyday Sounds* and the table below to analyze George's exposure to sound. Enter an estimated dB level for each sound listed in the first column. Where appropriate, indicate how the risk of hearing loss might be lowered. In the right column, enter any information that explains your dB estimates. For example, your choice of a dB level for eating lunch assumes either a quiet or a noisy environment.

Source of sound (major activities)	Time per week (minutes)	Estimated dB level	Suggestions for lowering risk of hearing loss	Comments
morning activities	180			
breakfast at home	100			
breakfast at fire station	120			
tending animals	840			
plowing fields	1020			
lunch at home	150			
lunch at fire station	90			
time on firetruck	240			
dinner at home	600			
remodeling work	960			
listening to music	1000			
watching TV	500			
reading	500			

Hearing-Risk Evaluation Form

Name_____ **Date**_____

Name of fictitious individual:_____

My evaluation is that this individual is (check one)

_____ not at risk for noise-induced hearing loss.

_____ at risk for noise-induced hearing loss.

Justify your evaluation based on all of the information in the individual's sound diary. If you suggested a way to decrease the risk of hearing loss, indicate specifically how this action will help.

Ten Ways to Recognize Hearing Loss

Name_____ **Date**_____

The following questions will help you determine whether you need to have your hearing evaluated by a medical professional.

1. Do you have a problem hearing over the telephone?
   Yes No
2. Do you have trouble following the conversation when two or more people are talking at the same time?
   Yes No
3. Do people complain that you turn the TV volume up too high?
   Yes No
4. Do you have to strain to understand conversation?
   Yes No
5. Do you have trouble hearing in a noisy background?
   Yes No
6. Do you find yourself asking people to repeat themselves?
   Yes No
7. Do many people you talk to seem to mumble (or not speak clearly)?
   Yes No
8. Do you often misunderstand what others are saying and respond inappropriately?
   Yes No
9. Do you have trouble understanding the speech of women and children?
   Yes No
10. Do people get annoyed because you misunderstand what they say?
    Yes No

If you answered "yes" to three or more of these questions, you may want to see an otolaryngologist (an ear, nose, and throat doctor) or an audiologist for a hearing evaluation.

The material on this page is for general information only and is not intended for diagnostic purposes. A doctor or other healthcare professional must be consulted for diagnostic information and advice regarding treatment.